WORK IT OUT

A maths workbook — concepts, worked examples, graded practice and number puzzles

Do the Learn First pages before the practice. Do the practice before the puzzles. Full solutions are at the back — but they only help you after you have tried.

Part	What it is	How to use it	Time
1	Learn First	Read and annotate. Copy every worked example by hand.	25 min
2	Worked Examples	Cover the solution. Try. Then compare line by line.	20 min
3	Guided Practice	Steps are given; you fill the gaps.	15 min
4	Practice Set A · Fluency	Straight application. Aim for speed and accuracy.	20 min
5	Practice Set B · Reasoning	Multi-step. Show every line.	25 min
6	Practice Set C · Challenge	Stretch problems. One may beat you — that is fine.	25 min
7	The Crossnumber	Answers are numbers. Wrong maths will not fit.	20 min
8	Number Search, Magic Square & Concept Bingo	Solo or with a partner.	20 min
9	Spot the Mistake	Audit a worked solution. Find the planted error.	15 min
10	Quick-Fire Round	Matching, True/False, Two Truths and a Lie.	15 min
11	The Escape Challenge	Teams of 4.	25 min

Part 1 · Learn First

A circle is one shape, but it hides dozens of areas inside it — slices, crusts and combinations. These pages give you the three formulas that unlock all of them.

Circumference and area of a circle

Two formulas you already know from earlier classes — the whole toolkit for this chapter is built on top of them.

Unless a question says otherwise, use $\pi = \frac{22}{7}$ when the radius is a multiple of 7, and $\pi = 3.14$ otherwise. Both are **approximations** — π itself is irrational.

A **sector** is the region enclosed by two radii and the arc between them (a "slice of pizza"). A **segment** is the region enclosed by a chord and the arc it cuts off (a "slice with the crust cut straight across"). The **minor** sector/segment is the smaller of the two pieces; the **major** one is the rest.

Quantity	Formula	Meaning
Circumference	$2\pi r$	distance all the way round the circle
Area	πr^2	region enclosed by the circle
Diameter	$d = 2r$	a chord passing through the centre

Rule to remember

- Angle of the major sector ¿ $360^\circ - \theta$, where θ is the angle of the minor sector.
- Area of major sector ¿ πr^2 − ¿ area of minor sector.
- Area of major segment ¿ πr^2 − ¿ area of minor segment.

Area of a sector and a segment — the angle fraction

A sector of angle θ is simply a *fraction* $\frac{\theta}{360}$ of the whole circle — for area, for arc length, everything scales the same way.

$$Length\ of\ arc = \frac{\theta}{360} \times 2\pi r$$

$$Area\ of\ sector = \frac{\theta}{360} \times \pi r^2$$

Segment = sector minus triangle. To find the area of the segment cut off by a chord, first find the area of the sector on the same arc, then subtract the area of the triangle formed by the two radii and the chord.

$$Area\ of\ segment = Area\ of\ sector - Area\ of\ \Delta OAB$$

Why the fraction works

- The full circle is "a sector of angle 360°", with area πr^2.
- By the Unitary Method, angle 1° sweeps area $\frac{\pi r^2}{360}$.
- Angle θ therefore sweeps $\frac{\theta}{360} \times \pi r^2$ — exactly the same reasoning gives the arc-length formula.

Sector and segment for a 90° angle

A chord of a circle of radius 10 cm subtends a right angle at the centre. Find the area of the minor segment. (Use $\pi = 3.14$)

Area of sector $= \frac{90}{360} \times 3.14 \times 10^2 = \frac{1}{4} \times 314 = 78.5$ cm^2.

Since $\theta = 90^\circ$, ΔOAB is right-angled at O with both legs $= 10$ cm, so its area $= \frac{1}{2} \times 10 \times 10 = 50$ cm^2.

Area of segment $= 78.5 - 50 = 28.5$ cm^2.

Areas of combinations of plane figures

Real objects — brooches, umbrellas, table covers, grazing horses — are rarely a single circle. Break the figure into circles, sectors, triangles and squares, then add or subtract.

Standard strategy: (1) identify the plane shapes hiding inside the figure, (2) find each area separately using the formula that fits, (3) add the areas that are *combined* and subtract the areas that are *removed* or *shared*.

A rope tied to a corner of a square field lets an animal graze a quarter circle (a 90° sector) — the square only limits how far the rope can swing, it does not change the sector formula.

Common combination patterns

- **Ring/annulus:** area between two concentric circles $\pi R^2 - \pi r^2 = \pi(R^2 - r^2)$.
- **Quadrant:** a sector of angle 90°, i.e. $\frac{1}{4}$ of the full circle.
- **Equally-spaced sectors:** if n identical sectors share a circle, each has angle $\frac{360}{n}$ and area $\frac{1}{n} \times \pi r^2$.

Grazing area at a corner of a square field

A horse is tied to a peg at one corner of a square field of side 15 m with a 5 m rope. Find the area it can graze. (Use $\pi = 3.14$)

The horse can sweep out a quarter circle of radius 5 m — a 90° sector, because the two field-edges at the corner form a right angle.

Area $= \frac{90}{360} \times \pi r^2 = \frac{1}{4} \times 3.14 \times 25 = 19.625$ m^2.

Answer: the horse can graze 19.625 m^2.

Part 2 · Worked Examples

Cover the right-hand column with a sheet of paper. Try the problem yourself first. Then uncover it one line at a time and check where your reasoning parted from the model.

Example 1 — Find the area of the sector of a circle with radius 4 cm and angle 30°, and the corresponding major sector. (Use $\pi = 3.14$)

Step 1. Area of minor sector $= \frac{\theta}{360} \times \pi r^2 = \frac{30}{360} \times 3.14 \times 16$.

$= \frac{1}{12} \times 50.24 = 4.19$ cm^2 (approx).

Step 2. Area of the full circle $= \pi r^2 = 3.14 \times 16 = 50.24$ cm^2.

Step 3. Area of major sector $= 50.24 - 4.19 = 46.05 \approx 46.1$ cm^2.

Answer: minor sector ≈ 4.19 cm^2; major sector ≈ 46.1 cm^2.

> **Why this works**
>
> Alternatively the major sector can be found directly using angle $360 - 30 = 330^\circ$: $\frac{330}{360} \times 3.14 \times 16 \approx 46.1$ cm^2 — same answer, one fewer subtraction to trust.

Example 2 — Find the area of a quadrant of a circle whose circumference is 22 cm. (Use $\pi = \frac{22}{7}$)

Step 1. Circumference $= 2\pi r = 22$, so $r = \frac{22}{2\pi} = \frac{22}{2} \times \frac{7}{22} = \frac{7}{2}$ cm.

Step 2. A quadrant is a sector of angle 90°, i.e. $\frac{1}{4}$ of the circle.

Step 3. Area of quadrant $= \frac{1}{4}\pi r^2 = \frac{1}{4} \times \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2}$.

$= \frac{1}{4} \times \frac{22 \times 7}{4} = \frac{154}{16} = 9.625$ cm^2.

Answer: 9.625 cm^2.

> **Why this works**
>
> Finding r from the circumference first is the key move — many students try to guess a radius instead of solving for it.

Example 3 — The minute hand of a clock is 14 cm long. Find the area swept by it in 5 minutes. (Use $\pi = \frac{22}{7}$)

Step 1. In 60 minutes the minute hand sweeps a full 360°, so in 1 minute it sweeps 6°.

Step 2. In 5 minutes it sweeps $\theta = 5 \times 6 = 30^\circ$.

Step 3. Area swept $= \frac{\theta}{360} \times \pi r^2 = \frac{30}{360} \times \frac{22}{7} \times 14 \times 14$.

$= \frac{1}{12} \times 616 = 51.33$ cm^2 (approx).

Answer: the area swept is ≈ 51.3 cm^2.

> **Why this works**
>
> The area "swept" by a hand is always a sector — the hand itself is a radius, and its tip traces the arc.

Example 4 — A chord of a circle of radius 21 cm subtends an angle of 60° at the centre. Find the area of the minor segment. (Use $\pi = \frac{22}{7}$ and $\sqrt{3} = 1.73$)

Step 1. Since $\theta = 60^\circ$, ΔOAB is **equilateral** (two radii equal, and the included angle 60° forces the third angle pair to be 60° each too), so its area $= \frac{\sqrt{3}}{4} r^2$.

Step 2. Area of sector $= \frac{60}{360} \times \frac{22}{7} \times 21 \times 21 = \frac{1}{6} \times 1386 = 231$ cm^2.

Step 3. Area of $\Delta OAB = \frac{\sqrt{3}}{4} \times 441 = \frac{1.73}{4} \times 441 \approx 190.7$ cm^2.

Step 4. Area of segment $= 231 - 190.7 = 40.3$ cm^2 (approx).

Answer: the minor segment has area ≈ 40.3 cm^2.

> **Why this works**
>
> Spotting that a 60° sector always gives an **equilateral** triangle saves you from dropping a perpendicular and using trigonometry every time.

Part 3 · Guided Practice

The method is laid out for you. Fill in the blanks. If you can do these without looking back at Part 2, you are ready for Part 4.

1. Find the area of a sector of a circle with radius 6 cm and angle 60°. (Use $\pi = \frac{22}{7}$)

Area of sector ¿ $\frac{\theta}{360} \times \pi r^2 = \frac{¿_¿}{360} \times \frac{22}{7} \times {}^2_¿ ¿$

¿ $\frac{1}{6} \times \frac{22}{7} \times 36 =$ ¿ _____ cm❑^{2}.

---

2. A car has a wiper blade of length 25 cm sweeping through 115°. Find the area cleaned by one sweep. (Use $\pi = \frac{22}{7}$)

The area cleaned by one sweep is a sector of angle _____ and radius _____ .

Area ¿ $\frac{115}{360} \times \frac{22}{7} \times 25^2 =$ ¿ _____ cm❑^{2} (approx).

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3. A circle has radius 7 cm. Find the area of the ring (annulus) between this circle and a concentric circle of radius 14 cm.

Area of larger circle ¿ $\pi \times {}^2_¿$; area of smaller circle ¿ $\pi \times {}^2_¿$.

Area of ring ¿ $\pi(R^2 - r^2) = \frac{22}{7} \times ¿$

¿ _____ cm❑^{2}.

Practice Set A · Fluency

Straight application of the method. Aim to get every one right, then aim to get them right quickly.

#	Question	Your working and answer
1	Find the area of a sector of a circle with radius 21 cm and angle 60°.	
2	Find the circumference and area of a circle of radius 14 cm.	
3	Find the area of a quadrant of a circle of radius 7 cm.	
4	The minute hand of a clock is 21 cm long. Find the area swept by it in 10 minutes.	
5	A chord of a circle of radius 10 cm subtends a right angle at the centre. Find the area of the minor sector. (Use $\pi = 3.14$)	
6	Find the length of an arc of a circle of radius 12 cm that subtends an angle of 45° at the centre.	
7	An umbrella has 8 equally spaced ribs, treated as a flat circle of radius 45 cm. Find the area between two consecutive ribs.	

Practice Set B · Reasoning

Two or more steps, or a step you have to choose for yourself. Show every line — marks live in the working.

#	Question	Your working and answer
1	Find the area of the minor segment of a circle of radius 14 cm, when the angle of the corresponding sector is 90°.	
2	A chord of a circle of radius 15 cm subtends an angle of 60° at the centre. Find the areas of the minor and major segments. (Use $\pi = 3.14$, $\sqrt{3} = 1.73$)	
3	In a circle of radius 21 cm, an arc subtends an angle of 60° at the centre. Find (i) the length of the arc (ii) area of the sector (iii) area of the segment.	
4	A brooch is made of a circle of diameter 35 mm with 5 diameters drawn, dividing it into 10 equal sectors. Find the area of each sector.	
5	A round table cover has 6 equal designs, made by a circle of radius 28 cm divided into 6 sectors. Find the total area of the 6 designs.	
6	To warn ships, a lighthouse spreads red light over a sector of angle 80° to a distance of 16.5 km. Find the area of sea covered. (Use $\pi = 3.14$)	

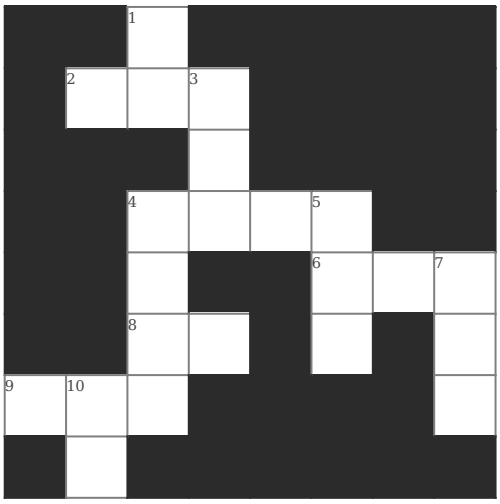
Practice Set C · Challenge

Harder, and deliberately so. If one defeats you, write down exactly where you got stuck. That sentence is worth more than a copied answer.

#	Question	Your working and answer
1	A chord of a circle of radius 12 cm subtends an angle of 120° at the centre. Find the area of the corresponding segment. (Use $\pi = 3.14$, $\sqrt{3} = 1.73$)	
2	A horse is tied to a peg at a corner of a square field of side 15 m by a rope 5 m long. Find the increase in grazing area if the rope is lengthened to 10 m. (Use $\pi = 3.14$)	
3	Two circles touch internally. Their radii are 10 cm and 6 cm. Find the area of the region between them.	
4	A square is inscribed in a circle of radius 7 cm. Find the area of the circle that lies outside the square (leave your answer using π and $\sqrt{2}$ where needed).	
5	A racetrack is in the shape of a ring whose inner and outer circumferences are 176 m and 220 m. Find the width of the track and the area of the track. (Use $\pi = \frac{22}{7}$)	

Part 7 · The Crossnumber

Every answer is a number. One digit per square. Because answers cross, a wrong calculation simply will not fit — this puzzle marks itself.



ACROSS

2. Area (cm²) of a quadrant of a circle of radius 14 cm, using π = 22/7 *(3 digits)*

4. Area (cm², ×100) of a circle of radius 20 cm, using π = 3.14 *(4 digits)*

6. Circumference (cm) of a circle of radius 21 cm, using π = 22/7 *(3 digits)*

8. Circumference (cm) of a circle of radius 14 cm, using π = 22/7 *(2 digits)*

9. Circumference (cm) of a circle of diameter 110 cm, using π = 22/7 (nearest whole) *(3 digits)*

DOWN

1. Radius (cm) squared for radius 5 cm *(2 digits)*

3. Area (cm²) of a sector of radius 21 cm and angle 120°, using π = 22/7 *(3 digits)*

4. Area (cm²) of a circle of radius 21 cm, using π = 22/7 *(4 digits)*

5. Area (cm²) of a circle of radius 14 cm, using π = 22/7 *(3 digits)*

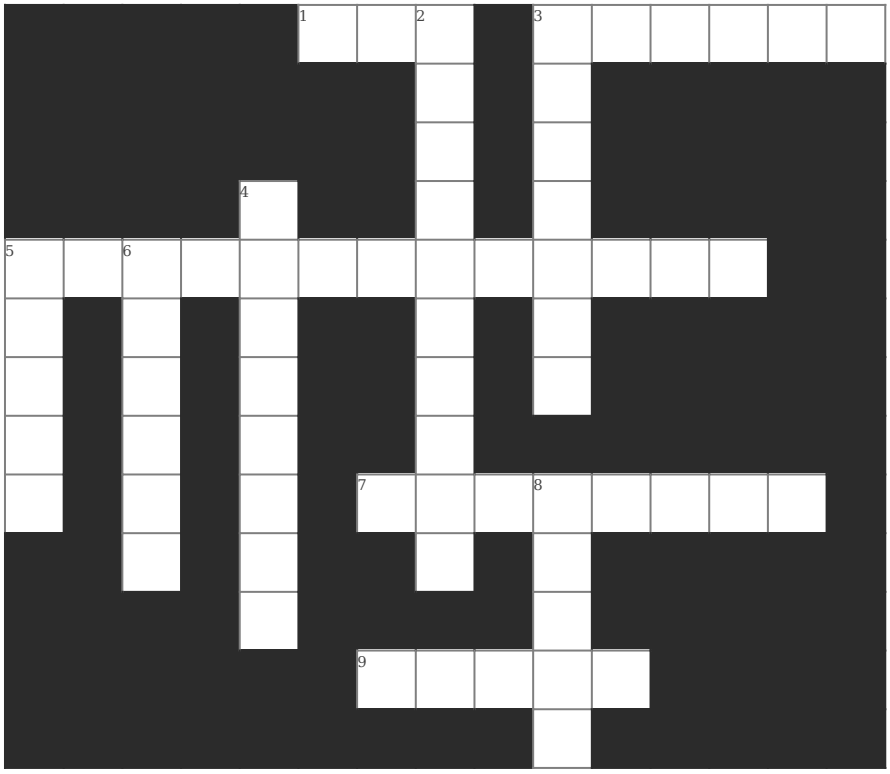
7. Area (cm²) of a sector of radius 21 cm and angle 60°, using π = 22/7 *(3 digits)*

10. Circumference (cm) of a circle of radius 7 cm, using π = 22/7 *(2 digits)*

Bonus questions that did not fit the grid — work them out anyway: Area (cm²) of a semicircle of radius 7 cm, using π = 22/7

Part 7b · The Crossword

Same rules as an ordinary crossword — but every word is maths vocabulary from this chapter.



ACROSS

1. A part of the circumference of a circle
3. Region enclosed by two radii and an arc
5. Distance all the way round a circle
7. A chord that passes through the centre
9. The larger of a pair of sectors or segments

DOWN

2. Circles that share the same centre
3. Region enclosed by a chord and an arc
4. A sector with angle ninety degrees
5. A line segment joining two points on a circle
6. Distance from centre to any point on a circle
8. The smaller of a pair of sectors or segments

Part 8 · Number Search & Magic Square

Work out each answer below, then find it hidden in the digit grid — across, down, diagonally or backwards.

1. Area (cm²) of a quadrant of radius 14 cm, π = 22/7
2. Circumference (cm) of a circle of radius 7 cm, π = 22/7
3. Area (cm²) of a circle of radius 14 cm, π = 22/7
4. Area (cm²) of a semicircle of radius 7 cm, π = 22/7
5. Circumference (cm) of a circle of radius 21 cm, π = 22/7
6. Area (cm²) of a 60° sector of radius 21 cm, π = 22/7
7. Area (cm²) of a circle of radius 21 cm, π = 22/7
8. Area (cm²) of a 120° sector of radius 21 cm, π = 22/7
9. Circumference (cm) of a circle of radius 14 cm, π = 22/7
10. Square of the radius, when radius is 5 cm

2	4	5	1	2	6	8	2	9	6	8	2	9
6	5	9	8	8	3	3	4	6	3	6	7	0
7	7	0	6	0	9	5	7	5	2	8	0	7
8	9	0	4	0	4	5	5	5	9	4	0	7
2	2	0	6	4	2	0	4	6	8	8	3	2
9	0	1	0	4	6	1	6	5	1	3	8	6
3	2	9	3	0	9	4	8	2	0	1	1	2
7	8	2	1	7	2	8	6	8	6	2	3	9
6	8	6	3	6	2	1	0	2	2	3	2	2
0	0	7	1	0	9	4	9	3	3	5	5	7
6	6	8	6	2	6	7	7	5	1	5	4	4
6	3	6	9	0	7	8	6	1	6	1	6	0
1	4	8	0	0	1	0	2	7	3	0	2	0

☐ 1386	☐ 154	☐ 616	☐ 132	☐ 231
☐ 462	☐ 44	☐ 77	☐ 88	☐ 25

Magic Square — every row, column and diagonal adds to the same total.

A 3×3 grid using the consecutive integers 1–9, one per box, every row, column and diagonal summing to the same magic constant.

8	**1**	
	5	**7**
		2

Magic constant: 15. Fill the empty cells.

Part 9 · Spot the Mistake

Each solution below reaches a wrong answer, and exactly one step is to blame. Find the first wrong step and rewrite it correctly. Marking other people's work is the fastest way to stop making their mistakes.

□ Spot the Mistake

Area of a sector of angle 90°, radius 7 cm

Step 1. Area ¿ $\frac{90}{360} \times \pi r^2$.

Step 2. ¿ $\frac{1}{4} \times \frac{22}{7} \times 7^2 = \frac{1}{4} \times 154 = 38.5$ cm□^{2}.

Step 3. Since the angle is 90°, the answer should be halved again, giving 19.25 cm□^{2}.

_____ The first wrong step is Step _____ . What should it say?

_____

□ Spot the Mistake

Area of the segment for a 60° chord, radius 21 cm (π = 22/7)

Step 1. Area of sector ¿ $\frac{60}{360} \times \frac{22}{7} \times 21^2 = 231$ cm□^{2}.

Step 2. The chord and two radii form an equilateral triangle, area ¿ $\frac{\sqrt{3}}{4} r^2$.

Step 3. Area of segment ¿ sector area + ¿ triangle area ¿ $231 + 190.7 = 421.7$ cm□^{2}.

_____ The first wrong step is Step _____ . What should it say?

_____

□ Spot the Mistake

Area of the ring between two circles of radii 14 cm and 7 cm (π = 22/7)

Step 1. Area of ring ¿ $\pi R^2 - \pi r^2$.

Step 2. ¿ $\frac{22}{7} \times 14^2 - \frac{22}{7} \times 7^2$

Step 3. ¿ $\frac{22}{7} \times$ ¿ cm□^{2}.

_____ The first wrong step is Step _____ . What should it say?

_____

Part 10 · Quick-Fire Round

Match each circle quantity to its formula

Draw a line from each item on the left to its match on the right.

#	Left	Right (shuffled)
1	Circumference of a circle	$\pi(R^2 - r^2)$
2	Area of a circle	$\frac{\sqrt{3}}{4}r^2$
3	Length of an arc of angle θ	$\frac{\theta}{360} \times 2\pi r$
4	Area of a sector of angle θ	$\frac{\theta}{360} \times \pi r^2$
5	Area of a segment	Area of sector $-$¿ area of triangle
6	Area of a ring (annulus)	πr^2
7	Area of an equilateral triangle of side r	$2\pi r$

True or False Sprint

Read each statement to yourself (or take turns with a partner). Decide True or False before you check the solutions.

#	Statement	Your call
1	A sector is bounded by two radii and an arc.	☐ True ☐ False
2	A segment is bounded by a chord and an arc.	☐ True ☐ False
3	The angle of the major sector is $360^\circ - \theta$.	☐ True ☐ False
4	Area of a segment is always the sum of a sector and a triangle.	☐ True ☐ False
5	$\pi = \frac{22}{7}$ exactly.	☐ True ☐ False
6	A quadrant is a sector of angle 90°.	☐ True ☐ False
7	The area swept by a clock hand in a given time is a sector.	☐ True ☐ False
8	Doubling the radius of a circle doubles its area.	☐ True ☐ False

#	Statement	Your call
9	Two concentric circles always enclose a ring of equal width all around.	☐ True ☐ False
10	When $\theta = 60^\circ$, the triangle formed by the two radii and the chord is equilateral.	☐ True ☐ False
11	Area of the major segment ¿ $\pi r^2 -$ ¿ area of minor segment.	☐ True ☐ False
12	The length of an arc depends only on the angle, not on the radius.	☐ True ☐ False

Two Truths and a Lie

Two statements are true, one is false. Circle the lie — then correct it.

Set 1

(a) Area of a sector of angle θ is $\frac{\theta}{360} \times \pi r^2$.

(b) Area of a segment equals area of sector minus area of triangle.

(c) Area of the major sector is always less than the area of the minor sector.

The lie is _____ . Corrected: _____

Set 2

(a) A quadrant is a sector with a 90° angle.

(b) The area of a ring between two concentric circles is $\pi R^2 - \pi r^2$.

(c) $R^2 - r^2$ is the same as ¿.

The lie is _____ . Corrected: _____

Set 3

(a) The minute hand of a clock sweeps 6° every minute.

(b) $\pi = \frac{22}{7}$ is an exact value of π.

(c) When $\theta = 60^\circ$, the chord-and-radii triangle is equilateral.

The lie is _____ . Corrected: _____

Part 11 · The Escape Challenge

Five gates, each a calculation. Each gives you one digit. Collect all five to unlock the exit code.

□ GATE 1 — The Circle Gate

Find the area (cm²) of a circle of radius 7 cm, using $\pi = \frac{22}{7}$. Take the first digit of your answer.

Digit: □

□ GATE 2 — The Sector Gate

Find the area (cm²) of a sector of radius 21 cm and angle 60°, using $\pi = \frac{22}{7}$. Take the number of hundreds in your answer.

Digit: □

□ GATE 3 — The Quadrant Gate

A quadrant of a circle of radius 14 cm has what area (cm²), using $\pi = \frac{22}{7}$? Take the last digit.

Digit: □

□ GATE 4 — The Ring Gate

Two concentric circles have radii 14 cm and 7 cm. Find the area (cm²) of the ring between them, using $\pi = \frac{22}{7}$. Take the first digit.

Digit: □

□ GATE 5 — The Minute Gate

How many degrees does a minute hand sweep in one minute?

Digit: □

EXIT CODE: □ □ □ □ □

Formula Sheet

Cut this page out and keep it. Everything in this chapter, on one page.

Circumference of a circle

$$C = 2\pi r$$

Area of a circle

$$A = \pi r^2$$

Length of an arc of angle \theta

$$ell = \frac{\theta}{360} \times 2\pi r$$

Area of a sector of angle \theta

$$A_{sector} = \frac{\theta}{360} \times \pi r^2$$

Area of a segment

$$A_{segment} = A_{sector} - A_{\Delta OAB}$$

Area of a ring (annulus)

$$A_{ring} = \pi\left(R^2 - r^2\right)$$

Area of the equilateral triangle for \theta = 60^{\circ}

$$A_{\Delta} = \frac{\sqrt{3}}{4} r^2$$

Full Solutions

Not just answers — working. Compare your method with this one; if they differ but both reach the right answer, make sure you understand why yours also works.

Part 3 · Guided Practice

1. 132/7 ≈ 18.86 cm² · **2.** ≈ 1579.2 cm² · **3.** 462 cm²

Practice Set A

1. Area $¿\frac{60}{360}\times\frac{22}{7}\times21^2=\frac{1}{6}\times1386=231$ cm❑².

2. $C=2\pi r=2\times\frac{22}{7}\times14=88$ cm; $A=\pi r^2=\frac{22}{7}\times196=616$ cm❑².

3. Area of quadrant $¿\frac{1}{4}\times\frac{22}{7}\times49=38.5$ cm❑².

4. In 10 minutes the hand sweeps 60°. Area $¿\frac{60}{360}\times\frac{22}{7}\times21^2=231$ cm❑².

5. Minor sector angle $¿90^\circ$; area $¿\frac{90}{360}\times3.14\times100=78.5$ cm❑².

6. Arc length $¿\frac{45}{360}\times2\times\frac{22}{7}\times12=\frac{1}{8}\times\frac{528}{7}\approx9.43$ cm.

7. Each gap is a sector of angle $\frac{360}{8}=45^\circ$; area $¿\frac{45}{360}\times\frac{22}{7}\times45^2\approx795.2$ cm❑².

Practice Set B

1. Sector area $¿\frac{90}{360}\times\pi\times196=154$ cm❑² (π=22/7); triangle area $¿\frac{1}{2}\times14\times14=98$ cm❑²; segment $¿154-98=56$ cm❑².

2. Sector area $¿\frac{60}{360}\times3.14\times225=117.75$ cm❑²; equilateral triangle area $¿\frac{1.73}{4}\times225\approx97.3$ cm❑²; minor segment ≈20.4 cm❑²; major segment $¿\pi r^2-\text{minor}\approx706.5-20.4=686.1$ cm❑².

3. (i) Arc $¿\frac{60}{360}\times2\times\frac{22}{7}\times21=22$ cm; (ii) sector area $¿231$ cm❑²; (iii) segment $¿231-\frac{\sqrt{3}}{4}\times441\approx231-190.7=40.3$ cm❑².

4. Radius $¿17.5$ mm; each of 10 sectors has angle 36°, area $¿\frac{36}{360}\times\frac{22}{7}\times17.5^2\approx96.25$ mm❑².

5. Each design sector angle $\theta = 60^\circ$; sector area $\frac{60}{360} \times \frac{22}{7} \times 784 \approx 410.7$ cm^2; each design (segment) area $\approx 410.7 - \frac{1.7}{4} \times 784 \approx 77.5$ cm^2; total for 6 ≈ 464.8 cm^2.

6. Area $\frac{80}{360} \times 3.14 \times 16.5^2 \approx 189.97$ km^2.

Practice Set C

1. Sector area $\frac{120}{360} \times 3.14 \times 144 = 150.72$ cm^2; isoceles triangle (drop a perpendicular, $\cos 60^\circ$ trick) area ≈ 62.28 cm^2; segment ≈ 88.44 cm^2.

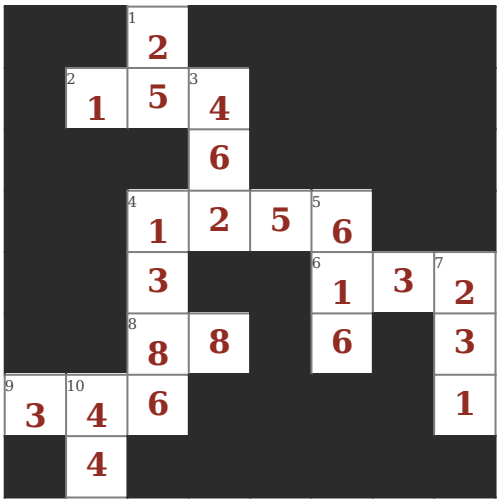
2. Grazing area with 5 m rope $\frac{90}{360} \times 3.14 \times 25 = 19.625$ m^2; with 10 m rope $\frac{90}{360} \times 3.14 \times 100 = 78.5$ m^2; increase 58.875 m^2.

3. Area between $\pi(10^2 - 6^2) = \pi \times 64 \approx 201.14$ cm^2 ($\pi = 22/7$ gives ≈ 201.14).

4. Square inscribed in a circle of radius 7 has diagonal 14, side $\frac{14}{\sqrt{2}} = 7\sqrt{2}$, area 98 cm^2. Circle area $\frac{22}{7} \times 49 = 154$ cm^2. Area outside the square $154 - 98 = 56$ cm^2.

5. $R = \frac{220}{2\pi} = 35$ m, $r = \frac{176}{2\pi} = 28$ m; width $R - r = 7$ m; track area $\pi(R^2 - r^2) = \frac{22}{7}(1225 - 784) = \frac{22}{7} \times 441 = 1386$ m^2.

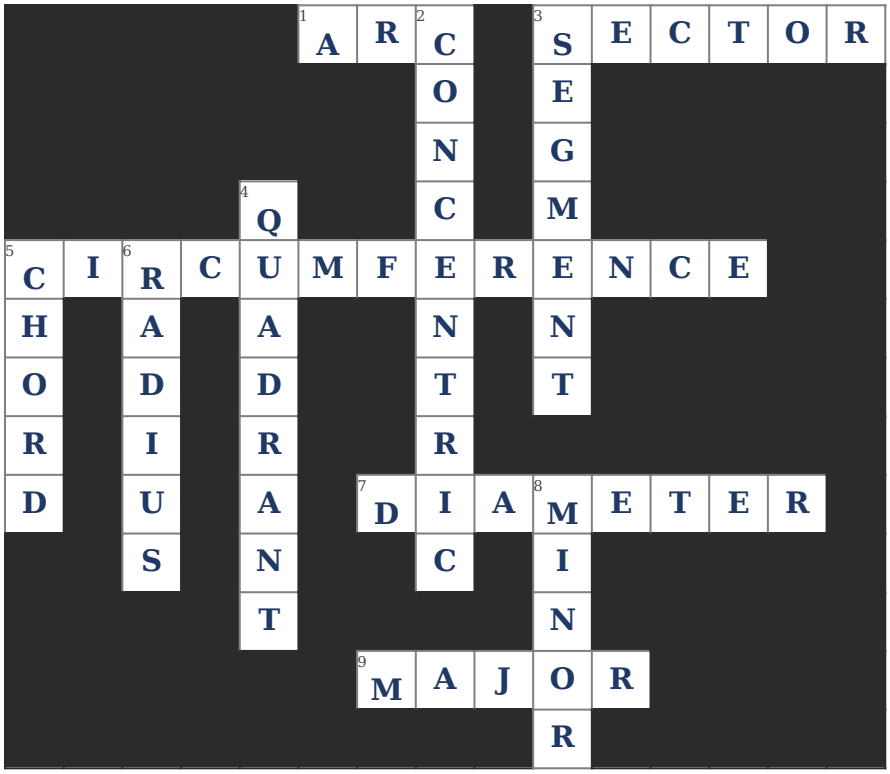
Part 7 · Crossnumber — Solved Grid



Across: 2 = 154 · 4 = 1256 · 6 = 132 · 8 = 88 · 9 = 346

Down: 1 = 25 · 3 = 462 · 4 = 1386 · 5 = 616 · 7 = 231 · 10 = 44

Part 7b · Crossword — Solved Grid



Across: 1 = ARC · 3 = SECTOR · 5 = CIRCUMFERENCE · 7 = DIAMETER · 9 = MAJOR

Down: 2 = CONCENTRIC · 3 = SEGMENT · 4 = QUADRANT · 5 = CHORD · 6 = RADIUS · 8 = MINOR

Part 8 · Number Search — Solved Grid

2	**4**	**5**	**1**	2	6	8	2	9	6	8	2	9
6	5	9	8	8	3	3	4	6	3	6	7	0
7	7	0	6	0	9	5	7	**5**	**2**	8	0	7
8	9	0	4	0	4	5	5	5	9	4	0	7
2	2	0	6	4	2	0	4	6	**8**	**8**	3	2
9	0	1	0	4	**6**	**1**	**6**	5	**1**	**3**	**8**	**6**
3	2	9	3	0	9	**4**	8	2	0	**1**	1	2
7	8	2	1	7	2	8	**6**	8	6	2	**3**	9
6	8	6	3	6	2	1	0	**2**	**2**	3	2	**2**
0	0	7	1	0	9	4	9	3	**3**	5	5	7
6	6	8	6	2	6	**7**	**7**	5	**1**	5	**4**	**4**
6	3	6	9	0	7	8	6	1	6	1	6	0
1	4	8	0	0	1	0	2	7	3	0	2	0

Part 8 · Magic Square — Solved (constant 15)

8	**1**	**6**
3	**5**	**7**
4	**9**	**2**

Part 9 · Spot the Mistake

Problem	First wrong step	It should say
Area of a sector of angle 90°, radius 7 cm	Step 3	The $\frac{\theta}{360}$ fraction already accounts for the angle — there is no extra halving. The correct area of the quadrant is 38.5 cm^2.
Area of the segment for a 60° chord, radius 21 cm (π = 22/7)	Step 3	The segment is the sector **minus** the triangle, not plus — the triangle is cut away from the sector to leave the curved sliver. Correct area $\approx 231 - 190.7 = 40.3$ cm^2.
Area of the ring between two circles of radii 14 cm and 7 cm (π = 22/7)	Step 3	$R^2 - r^2 \neq$ ¿. The correct working is $\frac{22}{7}(196 - 49) = \frac{22}{7} \times 147 = 462$ cm^2.

Part 10 · Matching

#	Left	Correct match
1	Circumference of a circle	$2\pi r$
2	Area of a circle	πr^2
3	Length of an arc of angle θ	$\frac{\theta}{360} \times 2\pi r$
4	Area of a sector of angle θ	$\frac{\theta}{360} \times \pi r^2$
5	Area of a segment	Area of sector − ¿ area of triangle

#	Left	Correct match
6	Area of a ring (annulus)	$\pi(R^2 - r^2)$
7	Area of an equilateral triangle of side r	$\frac{\sqrt{3}}{4} r^2$

Part 10 · True or False

1-T · 2-T · 3-T · 4-F · 5-F · 6-T · 7-T · 8-F · 9-T · 10-T · 11-T · 12-F

Part 10 · Two Truths and a Lie

Set	The lie	Correction
1	c	The major sector is the *larger* piece (angle $360 - \theta$), so its area is greater than the minor sector's whenever $\theta < 180^\circ$.
2	c	$R^2 - r^2 = (R - r)(R + r)$, which is not equal to ¿ unless $R + r = R - r$.
3	b	$\frac{22}{7}$ is only a close rational approximation to the irrational number π, never an exact value.

Part 11 · The Escape Challenge

EXIT CODE: 1 · 2 · 4 · 4 · 6

(Answer: 154 → 1) (Answer: 231 → 2) (Answer: 154 → 4) (Answer: 462 → 4) (Answer: 6)

Every pizza slice, brooch, umbrella panel and racetrack in this chapter is just a fraction of a circle — find the angle, apply the fraction, and the area follows. □□